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MORPHOLOGICAL INVESTIGATION ON POTATO MOTH PHTHORIMAEA *OPERCULELLA ZELLER, LEPIDOPTERA, GELECHIIDAE*

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INTRODUCTION

The potato tuber moth (Phthorimaea operculella Zeller) origins from the south region of North America. For the first time it was reported by Berthon in 1854 in the island of Tasmania. The species is widely spread and is known as a pest among the tropic and subtopic regions of America, Africa, Asia, Australia and Europe. It is transmitted through infected potatoes and other vegetative parts.

In Bulgaria, the potato moth was first found in Petrich and other regions in the surrounding of Blagoevgrad in 1950. It first came from Greece. Its highest presence was recorded in the course of 1952-1953. It was spread among tobacco plants and potatoes, but its presence gradually decreased in the succeeding years. In Bulgaria, its distribution was the highest in the regions of Blagoevgrad, Sofia, Haskovo and Plovdiv (7). More than 50 years after, the potato moth has been noticed again in Bulgaria. Throughout 2007 and 2008 damages were noticed on tobacco plants in the region of Plovdiv and Pazardjik.

The pest is not very well known among tobacco manufacturers, and the written documentation concerning the morphological specification of the species is quite scarce. This fact determines the goal of the current study: morphological investigation on potato moth Phthorimaea operculella Zeller.

MATERIALS AND METHODS

The basic observations on pests were made in 2007 and 2008, in the lab complex of ITTI in Plovdiv. Biological material was sampled from naturally infected tobacco plants in the experimental fields of ITTI - Plovdiv. The collected larvae were further nourished and bred under lab conditions. 142 eggs, 100 mature and 104 young larvae, 156 sexually separated pupae, and 124 male and female moths were observed in order to determine the size of different stages. Binocular with micrometrical scale was used to measure the size of the eggs of young larvae and pupas. Statistical processing of the results for all stages was done using Tool Pack MS Office Microsoft. The Student's t criterion was used to estimate the reliability of differences of the morphological characteristics between male and female imagos and pupae, measured in average values. Morphological determination of the imago wingspan and body length was made with n = 124, whereas of the pupal body length, width and weight with n = 156. The presence of the value of t exp > t tabl (t tabl = 2,576 with p = 1,0% and t tabl = 3,29 with p = 0,01%) points out to significant differences. There is a visual material attached to the morphological description by the author.

RESULTS AND DISCUSSION

Morphological description of potato moth

Imago

The adult insect is a small moth. The body is colored grey to dark brown on the upper part and it is brighter on the bottom. The head is bright brown to light gold, with little dark spots. The species have thread like antennas with flake like rings, colored in light and dark brown, covering almost the entire body. The wings at the front are narrow and long, with light yellow color. They also have darker spots. Upon a swing several spots on the wings form the letter "X". The wings at the back are shorter and grey and they have long threads on the back peripheral edge. Last abdominal segment is almost equal to 1/3 the length of the abdomen in the male. In female, the anal segment is of usual length. The apex of male abdomen is strongly pubescent, covered with dense, hairy bunches (Picture 1, 2).

Picture 1. The male moth of Phthorimaea operculella Zeller
Слика 1. Мажјак од Phthorimaea operculella Zeller

Picture 2. The female moth of Phthorimaea operculella Zeller
Слика 2. Женка од Phthorimaea operculella Zeller

The results of measurements of wingspan and body length are presented in Table 1. In females, the wingspan ranges from 10 to 18 mm and body length from 4 to 7 mm, whereas in males it ranges 10 – 16 mm and 4 - 7 mm respectively. The males and females are distincted by their wingspan and body length, and also by the presence of long grey hairs at two parts of the penultimate abdomen segments of the male species. Morphological description was made by Blachovsky, Graft, Lvovskii (2,4,5).

Significant statistical differences in wingspan and body length between moths of the two sexes were determined in this study. The obtained results reveal that differences between them are reliable (they actually exist): for the wingspan level of reliable p = 0,01 % with criterion of reliability t exp.= 11,9; for the body length p = 0,01% and t exp.= 3,93. Therefore, we can confirm that the female individuals are bigger than the male ones.

Table 1. Wingspan and body length of the imago of the Phthorimaea operculella Zeller
Табела 1. Распон на крилја и должина на телото кај имагото од Phthorimaea operculella Zeller

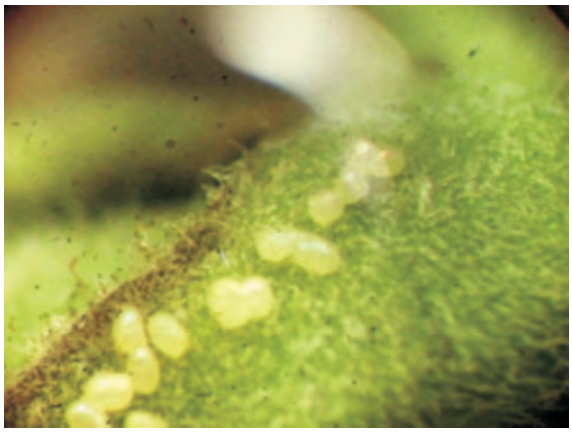
Sex Пол	Count Број	Wingspan, mm, Распон на крилја, mm	$S_{\bar{x}}$%	Body length, mm Должина на телото, mm	$S_{\bar{x}}$%
♂	124	13,11 ± 0,129	0,98	5,45 ± 0,062	1,1
♀	124	14,649 ± 0,129	0,88	5,766 ± 0,050	0.86

Egg

The egg of potato moth has a round shape. The chorion has a netlike structure and has a white color among the recently born eggs. The egg is 0,39 - 0,55 mm long and 0,25 - 0,4 mm wide. The results obtained from measurements of egg size (Table 2) are in agreement with those of Graf (4), who reported an average length of 0.48 mm. and width of 0.36 mm.

During the embryonic development, separate parts of the newly formed embryo can be seen through the chorion and it looks colored, due to the separation of the nucleus. Several days after hatching, the eggs become yellow and afterwards creamy, and in the equatorial part of the egg a red spot can be observed (Picture 3).

Later the color changes to orange-brown and on one side of the pole two black spots can be observed. One or two days before the egg is hatched, a well formed cranial box could be seen through the chorister – this is the so called black head phase.



Picture 3.The egg of Phthorimaea operculella Zeller
Слика 3. Јајца од Phthorimaea operculella Zeller

Table 2. Length and width of egg of the Phthorimaea operculella Zeller
Табела 2. Должина и ширина на јајца од Phthorimaea operculella Zeller

Count Број	Length, mm Должина, mm	$S_{\bar{x}}$%	Width, mm ширина, mm	$S_{\bar{x}}$%
142	0,484 ± 0,0036	0,74	0,336 ± ,004	1,19

Larva (caterpillar)

After hatching, the larvae have a bright white color with dark brown head and length from 1,05 to 1,65 mm. and width on the epicranium from 0,2 to 0,25 mm. The body of the caterpillar is covered with soft skin, and every segment has dark warts with hair. The basic color is grey to light green. Before reaching this stage, the dorsal part of the larva becomes pink. The mature larva is 10 - 15 mm long and 1,5 - 3,0 mm wide. The results of measurements of larval size are presented in Table 3. Data obtained in this study are in agreement with those of Graft (4), who reported that the full grown larva has 9.5 - 11.5 mm length and about 1.5 mm width, and Alvarez (1), who indicated that the length of young larva is 1,0 -2,0 mm and of mature larva 15 - 20 mm.

Table 3. Length and width of the young and mature larva of the Phthorimaea operculella Zeller
Табела 3. Должина и ширина на млада и возрасна ларва од Phthorimaea operculella Zeller

Count - Број Mature larva - возрасна ларва	Length, mm Должина, mm	$S_{\bar{x}}$ %	Width, mm ширина, mm	$S_{\bar{x}}$ %
100	12,68 ± 0,11	0,86	2,18 ± 0,04	1,83
Count - Број Young larva - млада ларва	Length, mm Должина, mm	$S_{\bar{x}}$ %	Width epicranium, mm ширина, mm	$S_{\bar{x}}$ %
104	1,307 ± 0.01	0,76	0,22 ± 0,002	0,91

Picture 4. The larva of Phthorimaea operculella Zeller
Слика 4. Ларва од Phthorimaea operculella Zeller

The head is dark brown to black. The breast shield is black, with bright stripe in the middle. The anal shield is yellowish, and often has darker spots. Every segment of the body has dark warts with hair. The breast legs are black, and the anal legs are yellowish (Picture 4). The two sexes of the caterpillar can be distinguished by the fact that the male has a dark spot that can be seen on the dorsal part of the fifth abdomen segment. This is the male genital organ.

Pupa

The pupa is a covered type, colored in cinnamon brown. The results obtained from measurements of pupal size are presented in Table 4. The length of the female pupa ranges 5,2 to 7,5 mm, the width 1,5 to 2.25 mm and the weight 0,005 to 0.017 g., and of the male 5,25 to 7,2 mm, 1,5 to 2,1 mm and 0,005 to 0,013 g, respectively. It develops in a silky cocoon of grayish silvery color. Immediately after formation, the pupa has a yellow-green color and later, before emergence, it becomes dark brown (Picture 5). The cremaster is formed from a hard thorn, subdorsally located, with a crooked tip like a hook. Both parts of the thorn contain 4 hairs. Chauhan (3) reported that the sexual dimorphism in the pupa shows many morphological characteristics: body length, width and weight of the pupa; shape and position of genital opening, position of posterior-most abdominal spiracle and shape of the caudal margin of the tenth abdominal segment. Morphological description of the pupa was made also by Sannino (6).

Picture 5. The pupa of Phthorimaea operculella Zeller
Слика 5. Кукла од Phthorimaea operculella Zeller

Picture 6. The pupa of Phthorimaea operculella Zeller; left - male, right - female
Слика 6. Кукла од Phthorimaea operculella Zeller; лево -мажјак, десно - женка

In the present study we determine that the genital opening is located on the eighth abdominal segment in the female pupa, while in the male pupa it is on the ninth segment (Picture 6). The shape of the caudal margin of the tenth abdominal segment of the male pupa has two well shaped sharpened parts, whereas the same can not be noticed on female individuals.

Table 4. Length, width and weight of the pupa of the Phthorimaea operculella Zeller
Табела 4. Должина, ширина и тежина на кукли од Phthorimaea operculella Zeller

Count Број	Sex Пол	Length, mm Должина, mm	$S_{\bar{x}}$%	Width, mm ширина, mm	$S_{\bar{x}}$%	Weight, g Тежина, g	$S_{\bar{x}}$%
156	♂	6,501 ± **0,033**	0,50	1,843 ± **0,011**	0,59	0,009 ± **0,000149**	1,62
156	♀	6,655 ± **0,039**	0,58	1,954 ± **0,013**	0,66	0,011 ± **0,000207**	1,88

The results from measurements of body length, width and weight of the pupa reveal significant statistical differences between the sexes. This indicates that differences between them are reliably differentiated (they actually exist): for the body length level of reliable p = 1,0 % with criterion of reliability t exp.= 3,027; for the body width p = 0,01% and t exp.= 6,52 and weight p = 0,01% and t exp= 6,85. Therefore, we can confirm that the potato female pupa is bigger than the male.

Description of damages

Potato moth is a pest that causes damages on tobacco plants in its caterpillar stage. The first damages were observed by the end of July and beginning of August in 2007, when the moth was first observed in Bulgaria, after its absence of over 50 years. The damages affected both oriental and large-leaf tobacco types. During 2008 the first damages were observed in June, a few weeks after transplanting. In the planting areas, however, damages were not found. Caterpillars of the potato moth attack the bottom leaves of the plant first, and afterwards they continue with the upper leaves. After hatching, the young caterpillar crawls for a while and looks for a place to start biting. The young caterpillars are much more flexible and active. Predominantly they start biting the basis of the leaves close to the main nerve. The caterpillars feed on the bottom and upper part of the leaf, which results in formation of mines. In the beginning, the mines are not easily noticed since they are narrow and twisted, but as the caterpillars grow, the mines become wider, with different sizes and shape. The mines are often located in the peripheral top part of the leaves, since the caterpillar moves towards the main nerve. In the mine, the caterpillar and its excrements can be clearly seen (Picture 7, 8).

Picture 7. Damaged Virginia tobacco leaf of Phthorimaea operculella Zeller
Слика 7. Лист од вирџиниски тутун оштетен од Phthorimaea operculella Zeller

Picture 8. Damaged oriental tobacco leaf of Phthorimaea operculella Zeller
Слика 8. Лист од ориенталски тутун оштетен од Phthorimaea operculella Zeller

In addition to mines on leaves, damages on tobacco stems were also observed. The caterpillars start biting under the bark of the stem and start moving with differently sized steps. This causes the damaged spot to cave in. As a result, the damaged stems become susceptible to strong winds, which were observed during the summer of 2007. The stems that were severely damaged were broken. The damaged leaves lose their trade value because when they are dried they start breaking.

CONCLUSIONS

Significant statistical differences in wingspan and body length between the moths of the two sexes were determined in the present study. According to the investigations, the female potato moth imago is bigger than the male.

The estimated size of moth's egg is 0,48 mm in length and 0,33 mm in size.

The length of the full grown larvae is 12,68 mm and the width is 2,18 mm, while in young larvae the length is 1,3 mm and the width 0,22 mm.

Results from the measurements of body length, width and weight of the pupa reveal significant statistical differences between the sexes. Therefrom, it can be stated that the female individuals are bigger than the male.

The specific damages on tobacco plants caused by potato tuber moth are also described in this paper.

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МОРФОЛОШКИ ПРОУЧУВАЊА НА КОМПИРОВИОТ МОЛЕЦ PHTHORIMAEA OPERCULELLA ZELLER, LEPIDOPTERA, GELECHIIDAE

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РЕЗИМЕ

Phthorimaea operculella Zeller е штетник на компирот во поле, како и на складираните компири. Компировиот молец напаѓа и на тутунот, доматот, модариот патлиџан, како и на др. растенија од фамилијата Solanaceae.

Во Бугарија, овој штетен вид е утврден за прв пат пред повеќе од 50 години. Денес штетите предизвикани од компировиот молец имаат се поголемо значење.

Во трудот се претставени резултатите од морфолошките проучувања на одделните стадиуми од овој вид. Утврдени се морфолошките разлики меѓу мажјаците и женките и статистички се докажани разлики во однос на должините на распон на крилјата на пеперутките и должината на нивните тела.

Утврдена е големината на јајцето на младата и возрасната ларва. Констатирано е дека женските кукли се со поголеми димензии од куклите на мажјаците, што е статистички потврдено.

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